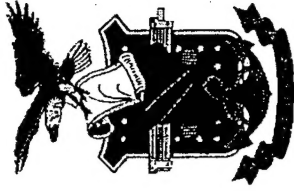


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A Comprehensive Approach to Teaching Avionics Systems Flight Test

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OPEN PUBLICATION

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NAVAL AIR SYSTEMS COMMAND

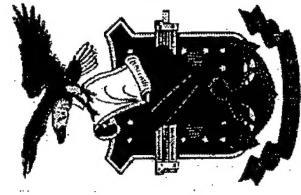
H. Howard

By

LCDR Doug Lucka,
USNTPS

Mr. Bill Michael,
USNTPS

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Overview

- USNTPS Mission
- Increased Importance of Systems Testing
- How to develop the “End Product”
- Tools and Methodologies
 - Past and Present Approaches
 - Challenges
- Summary

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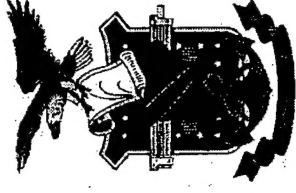
USNTPS Mission



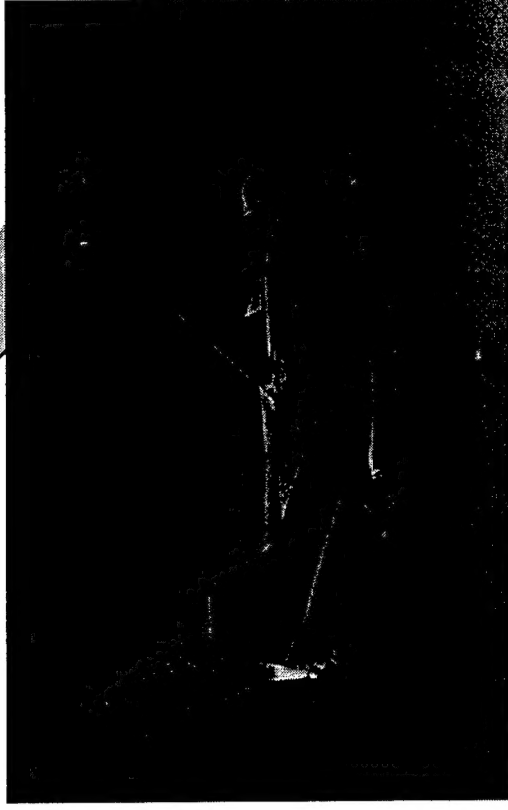
- Train:
 - Engineering Test Pilots
 - Engineering Test NFO/Weapon Systems Operators
 - Flight Test Engineers
- To Support:
 - Naval Aviation Systems Team and RDT&E Community

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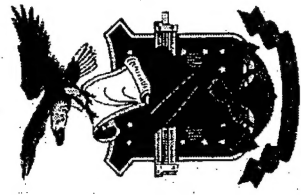
Why Systems Emphasis?



- Two Factors
 - Legacy/Aging Aircraft
- Legacy Systems Require Sensor/Avionics Upgrades to:
 - Remain operationally effective
 - Affordable readiness
 - Many current projects are driven by sheer cost of maintaining older, less reliable systems/sensors



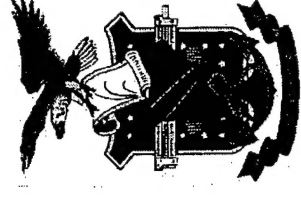
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Why Systems Emphasis?

- Shift in DoD Acquisition
 - COTS/NDI Acquisition Strategies
 - Typically FOT&E
 - Bulk of NAWC-AD Test Work
 - Management Misperceptions
- Modern Weapons Systems
 - Sub-system upgrades must be approached and tested as a “System” at the System level
- Significant percentage of graduates move on to “Systems Testing”

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Why Systems Emphasis?

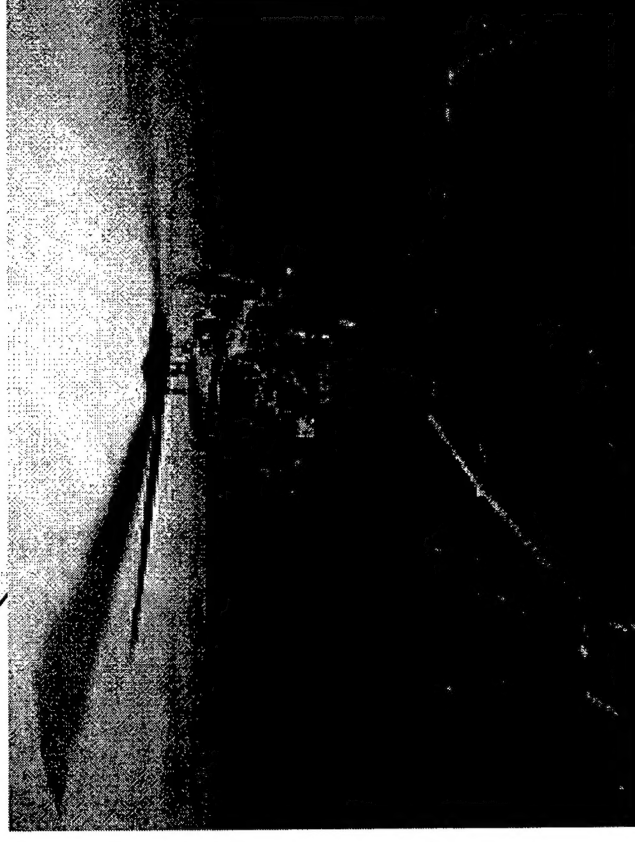
- NAWC-WD
 - F/A-18 Advanced Weapons Lab
 - Pt. Mugu
- NAWC-AD
 - Test Squadrons
- Many Graduates doing Systems Testing
vice Classical FQ&P
 - Still a requirement to Train to FQ&P
 - Customer Feedback - More Systems

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Systems Testing

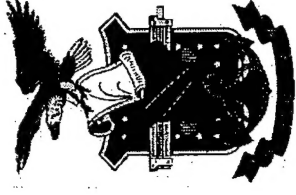


- Full spectrum of testing occurring at NAWC AD/WD
 - Navigation
 - P-3/S-3/F-18/E-2
 - C4I/SR
 - P-3/EP-3E/E-2C
 - Radars
 - V-22
 - EO/IR
 - ATFLIR/SH-60R/ SLAM-ER/
P-3
 - Computers/Software
 - AV-8B/F-18/S-3/E-2



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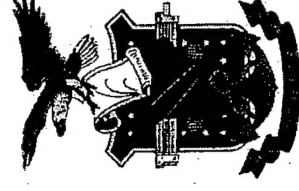
End Product



- Systems Tester - All Communities/All Positions
 - Pilots, NFOs and Engineers who can approach any Systems Acquisition, and Plan, Execute, and Report Flight Test
 - A “Toolbox” of sound methodologies to approach any Avionics Systems Test Program
 - Support a Program from CE to FOT&E
 - New or COTS/NDI

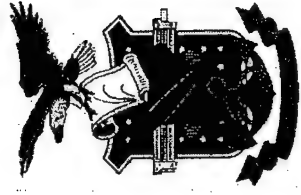
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Inputs to TPS



- Wide Variety of Mission Experience/
Academic Knowledge
 - E-2C to F/A-18 to P-3C to SH-60
 - Pilots, Systems Operators, Engineers
 - Varying Levels of Education
 - B.S. Business, to M.S. in EE, AE -Avionics

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Old Approaches

- Systems taught as a separate curriculum
 - Resulted in 2 kinds of test pilots
 - Systems
 - FQ&P
 - Not optimum for productivity/credibility
- Academics directly to Flight with minimal Lab/Simulation
 - A-7/A-4 was the vehicle for training systems

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Instructional Approach

Two Tiers of Exposure

Application of Theory

Students apply theory and test techniques to demonstrate mastery.

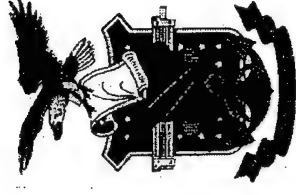
Presentation of Theory

Theory supporting T&E is introduced in the classroom.

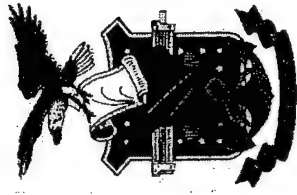
Airborne
Tactical
Aircraft
Evaluation

Academic Theory

Classroom



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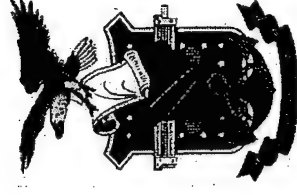


Shift to Current Approach

- Systems and Fixed Wing Academic syllabi joined
- F/A-18's arrive at the School
- Fix the "A" card "B" card problem
 - Teach FQ&P
 - Solid Basis in Systems
- Increased Lab/Simulation Capabilities

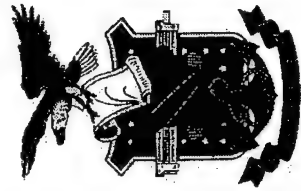
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USNTPS Systems Curricula



- A dedicated 48 week Systems Course
 - Naval Flight Officers/Flight Test Engineers
 - Focus is Airborne Systems, but get exposure to classical FQ&P Flight Test
- Fixed and Rotary Wing Pilots get Systems Training
 - Adding depth is a challenge
 - 48 Weeks - Full

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Instructional Approach

Multiple Tiers of Exposure

Application of Knowledge

Students apply theory and test techniques to demonstrate mastery.

Applied Theory and Flight Test Techniques

Theory learned in the classroom is combined with FTT in ground-based and airborne simulators and laboratories.

Presentation of Theory

Theory supporting T&E is introduced in the classroom.

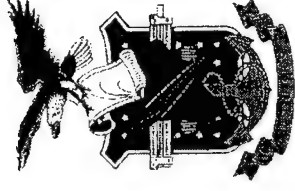
Airborne
Tactical
Aircraft
Evaluation

Airborne
Simulator and
Laboratory Exercises
Ground-based

Academic Theory
Classroom

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USNTPS Systems Flight Exercise Curricula Relationships



X Systems Exercises

-Radar - Qualitative

-EO/IR - Qualitative

-NVD - Qualitative

S Systems Exercises

-RCS

-Radar -Quantitative &
Qualitative

-EO/IR - Quantitative &
Qualitative

-NVD - Qualitative

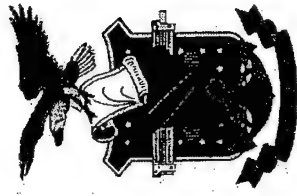
-Navigation- Quantitative
& Qualitative

R Systems Exercises

-Radar - Qualitative

-EO/IR - Qualitative

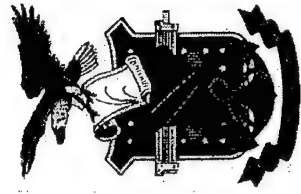
-Navigation - Quantitative &
Qualitative



Academics

- The “Foundation” which all else builds upon.
- All 3 Curricula get a basic core (first few months)
- Varying Levels between Curricula to Support the Flight Exercises
- Must Transition from the Chalkboard to the Lab

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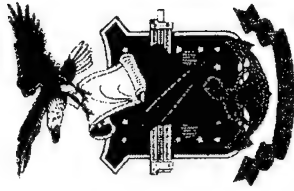


Lab

- Radar and EO/IR as well as basics of RF theory taught in Lab Environment]
- Visualize classroom concepts
 - Full Physics Based Air to Ground Radar Simulator
 - Vary Radar Parameters with software
 - Display things like: Unambiguous range, Blind Ranges, Range/Az Resolutions, etc.
- FLIR/LASER to teach EO/IR Fundamentals

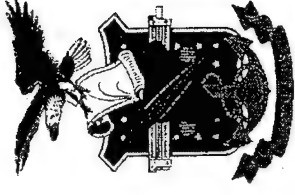
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Radar Simulator

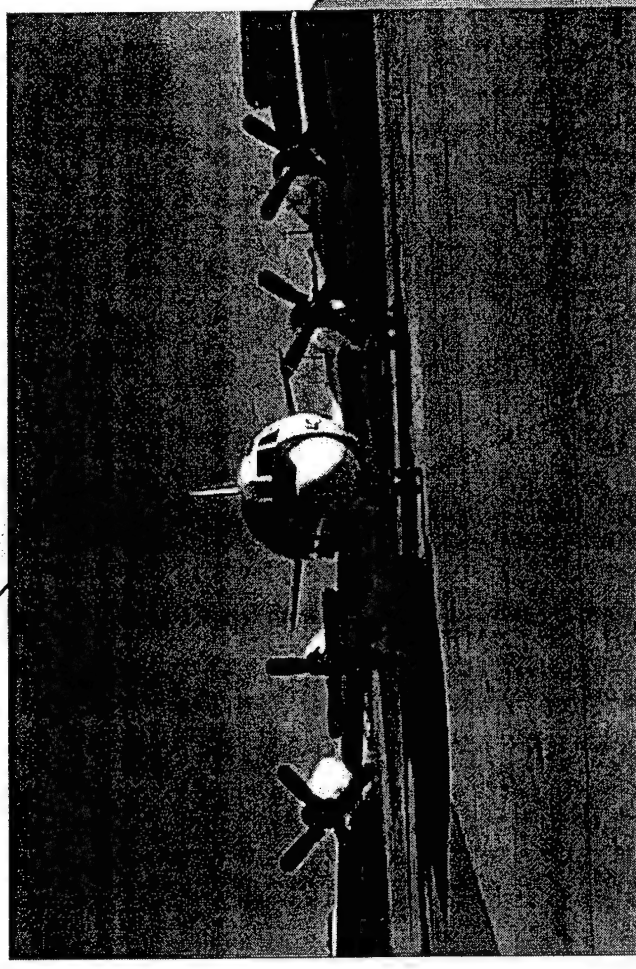


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USNTPS NP-3D

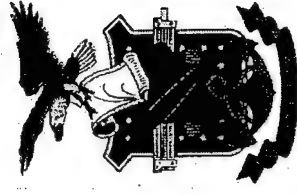


- The key element in USNTPS approach to systems is the NP-3D
 - Formerly a YP-3 Oceanographic Research Aircraft
 - Converted to an avionics “Test Bed” for use teaching systems test techniques



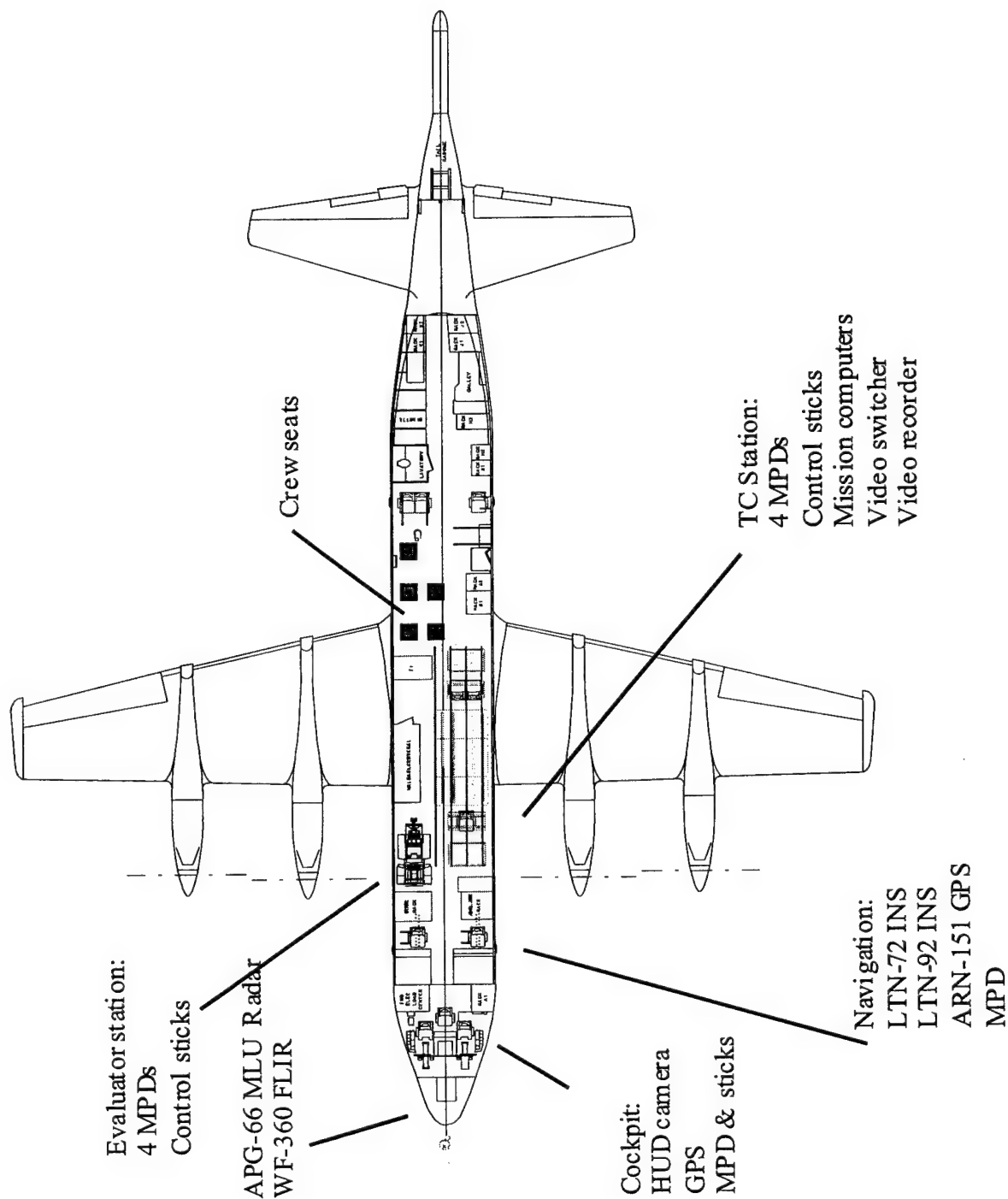
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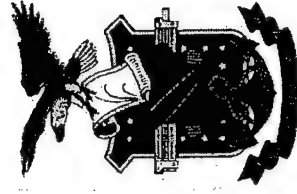
NP-3D Systems



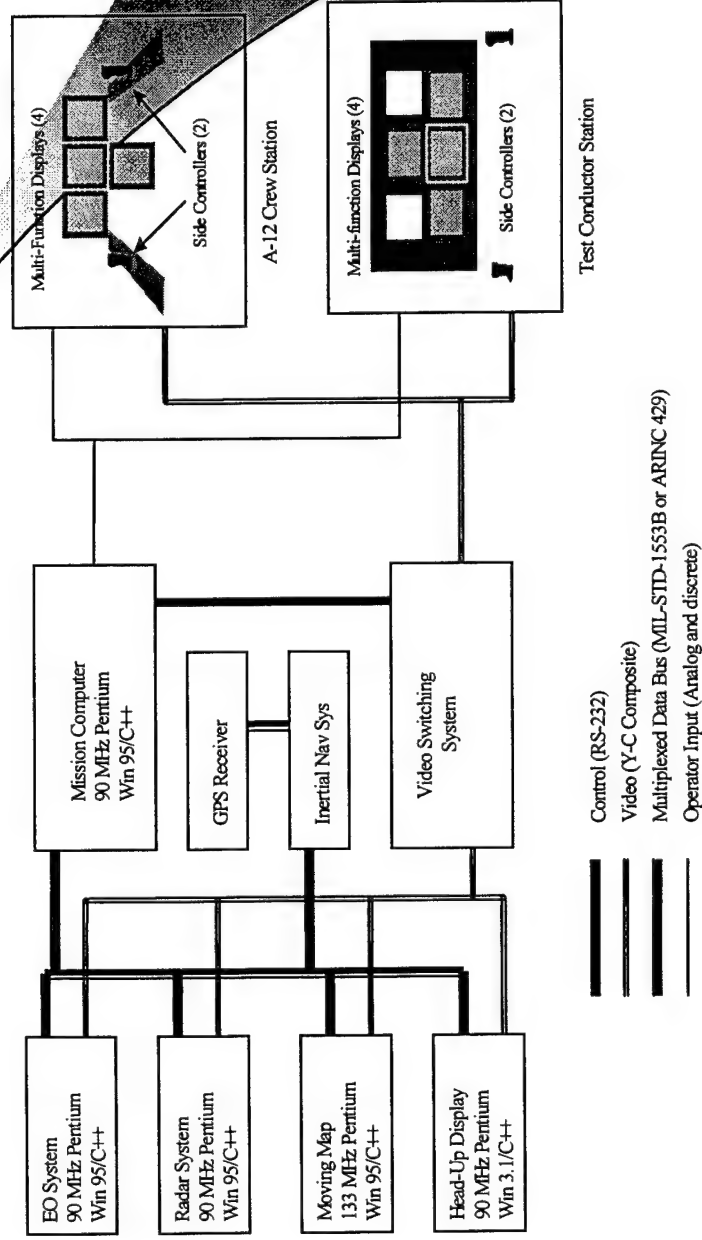
- APG-66(V)2 Mid-Life Upgrade (MLU) Radar
- WF-360TL FLIR/TV/LRF Electro-Optical System
- Moving Map Navigation System
- Simulated HUD Display
- Mission Computer
 - Four interface computers
- Two Crew Stations
 - Test Conductor and Evaluator
- Integrated Navigation System

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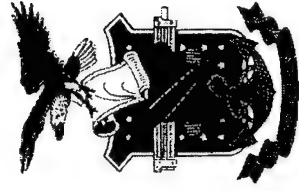




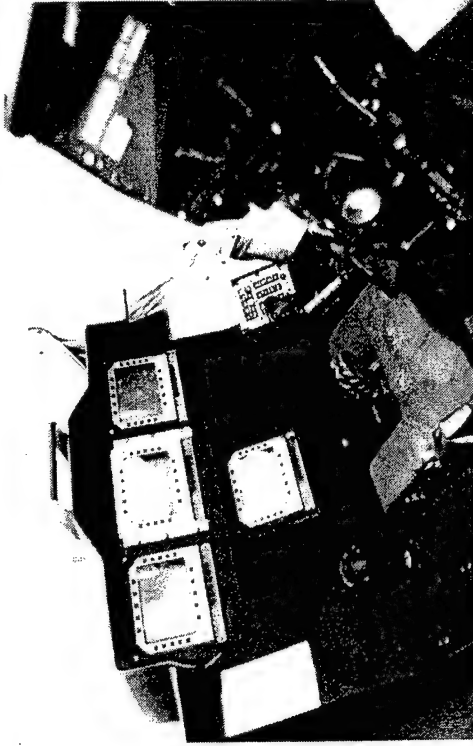
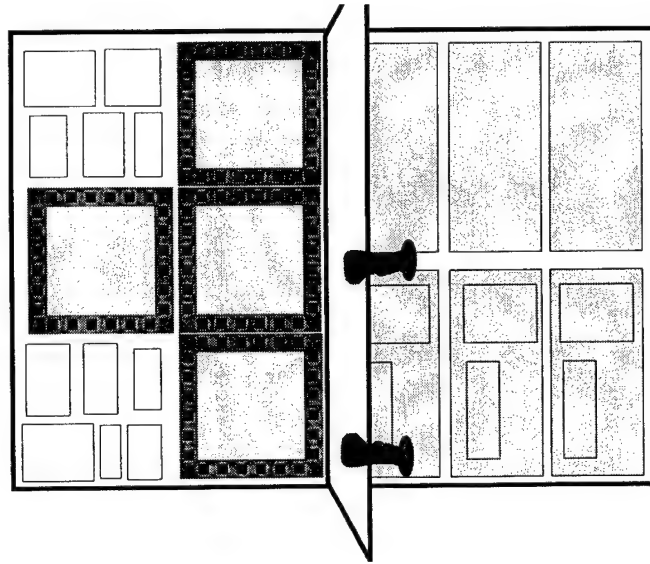
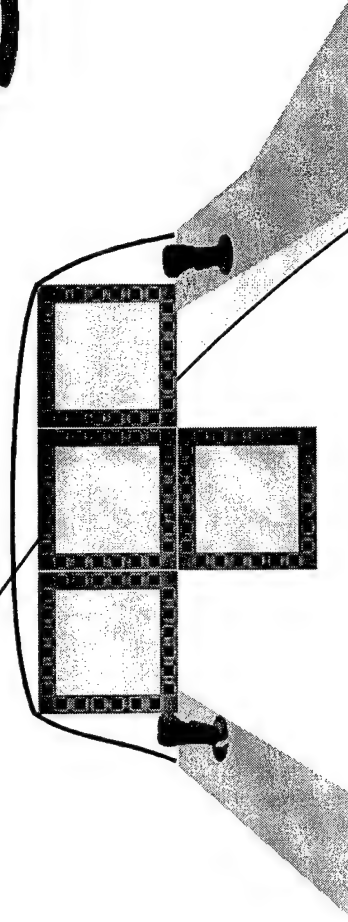
System Architecture



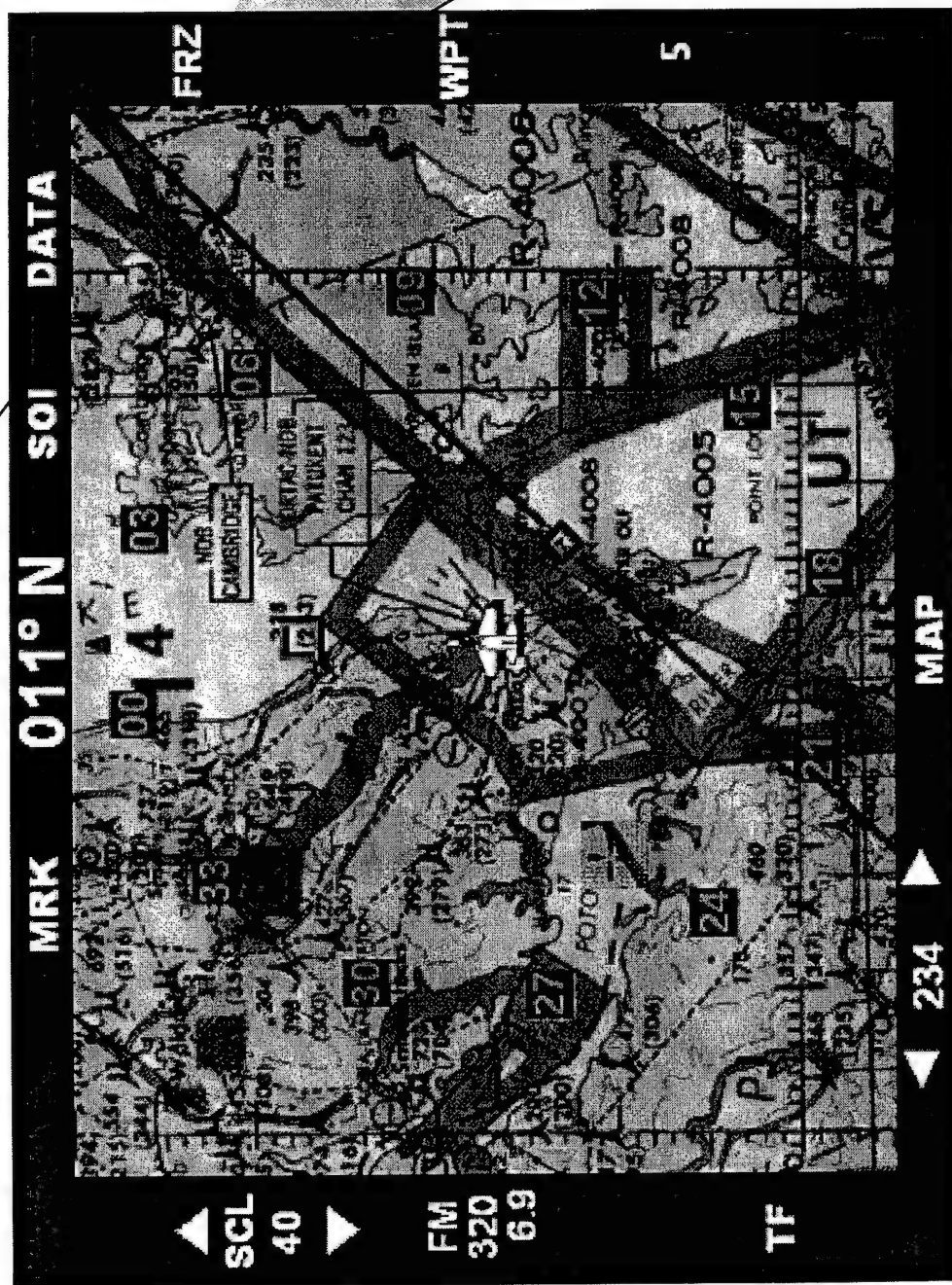
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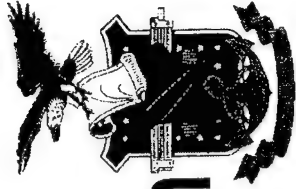


ASTARS Stations



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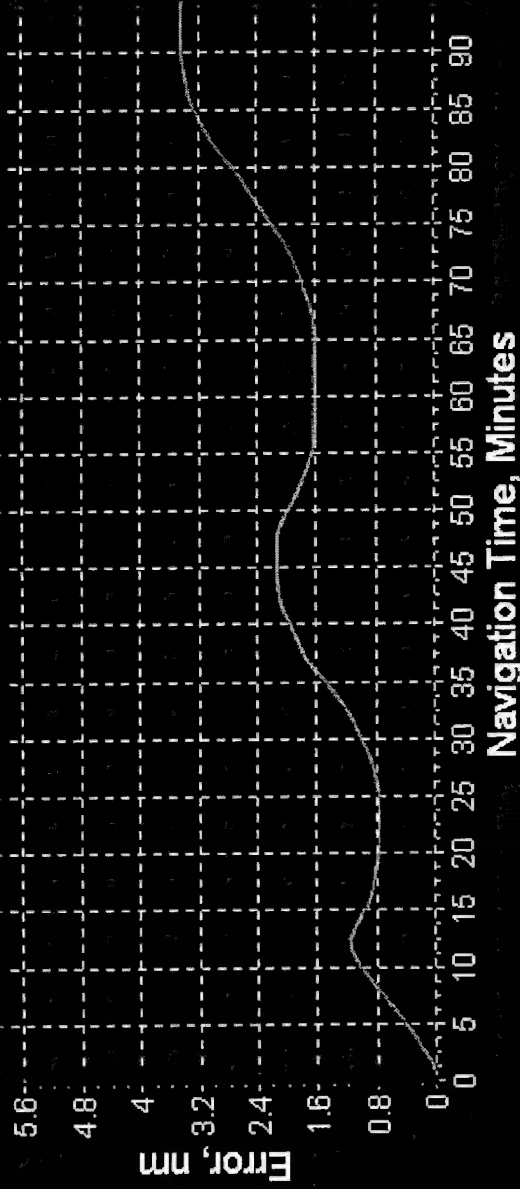


Navigation Instrumentation

Sample Period
10 Min.

Save to floppy
08FE2155

INS Position Errors (relative to GPS)

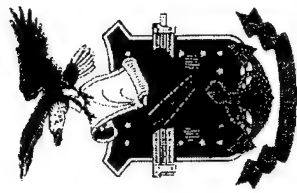


Plot Type
Total Errors

MAP Inst

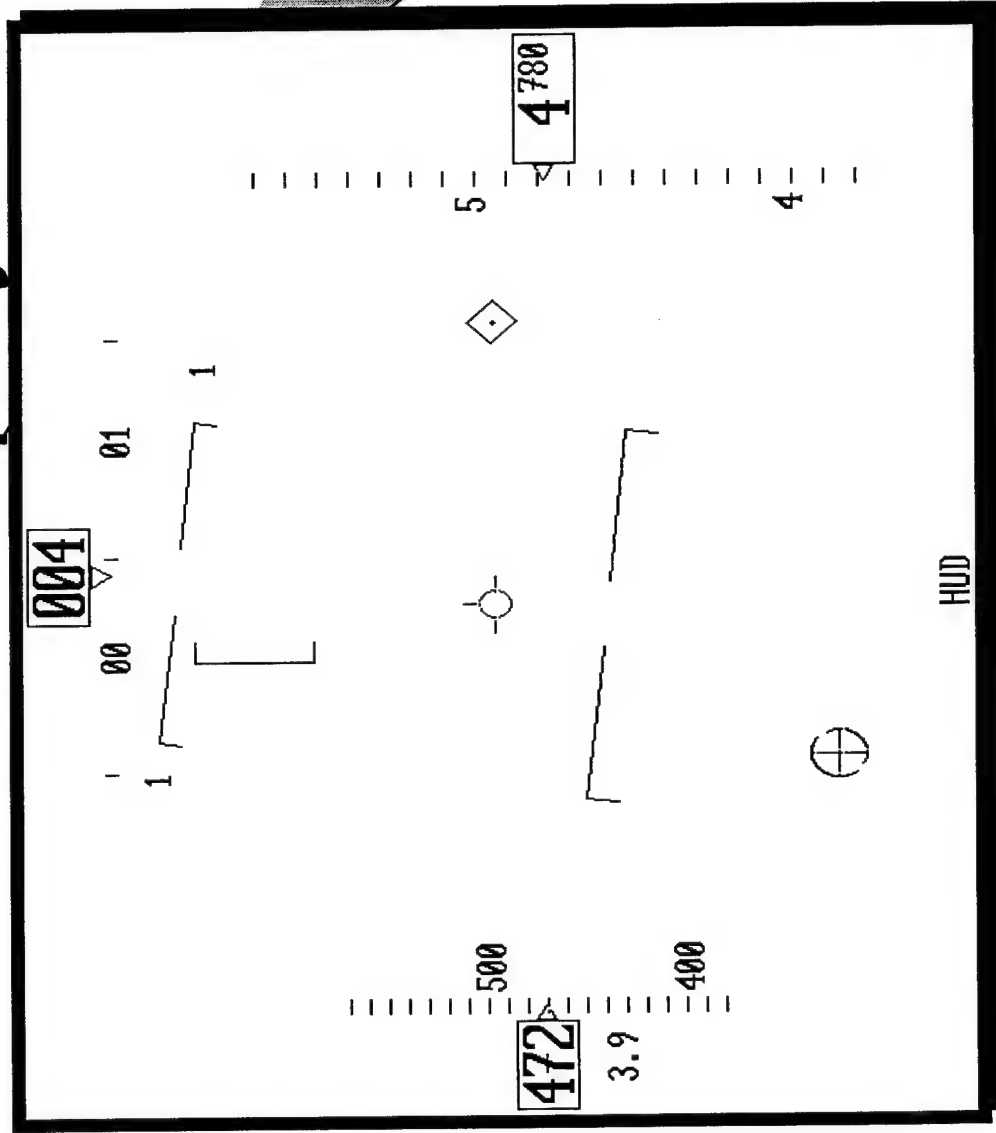
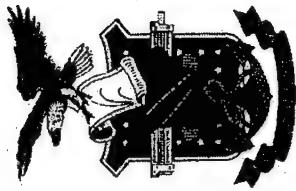
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FLIR/TV Display



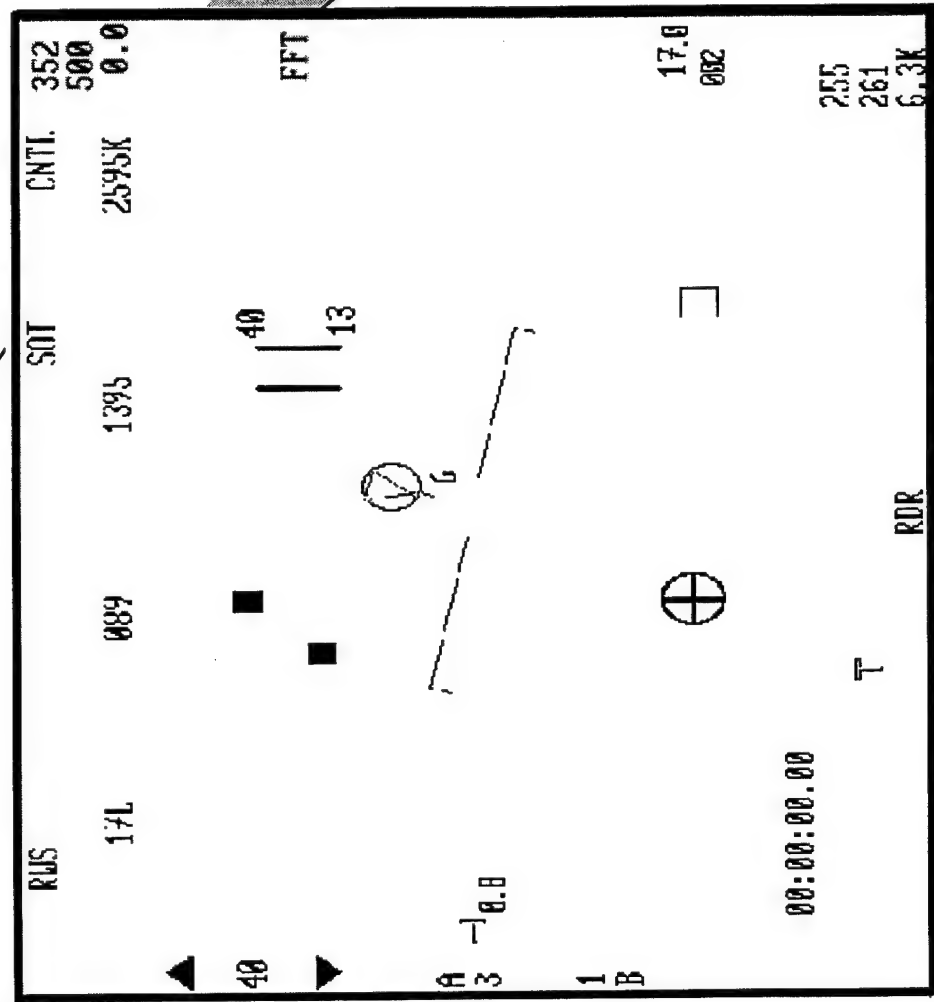
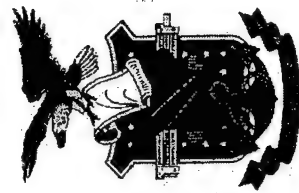
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HUD Display

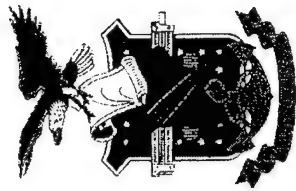


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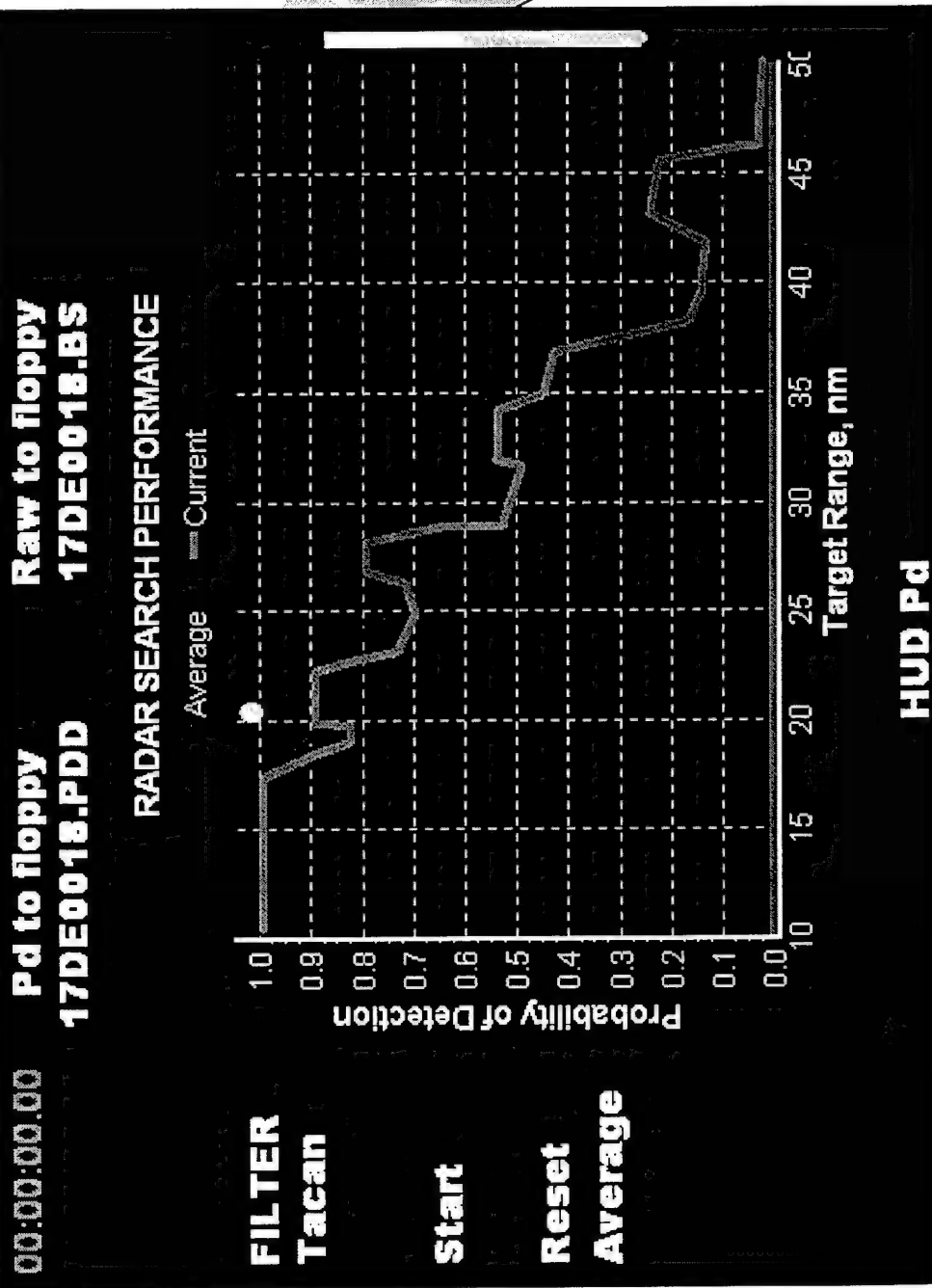
Air to Air Radar Display



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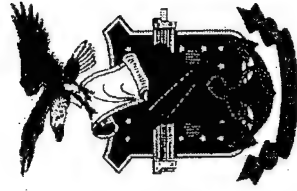
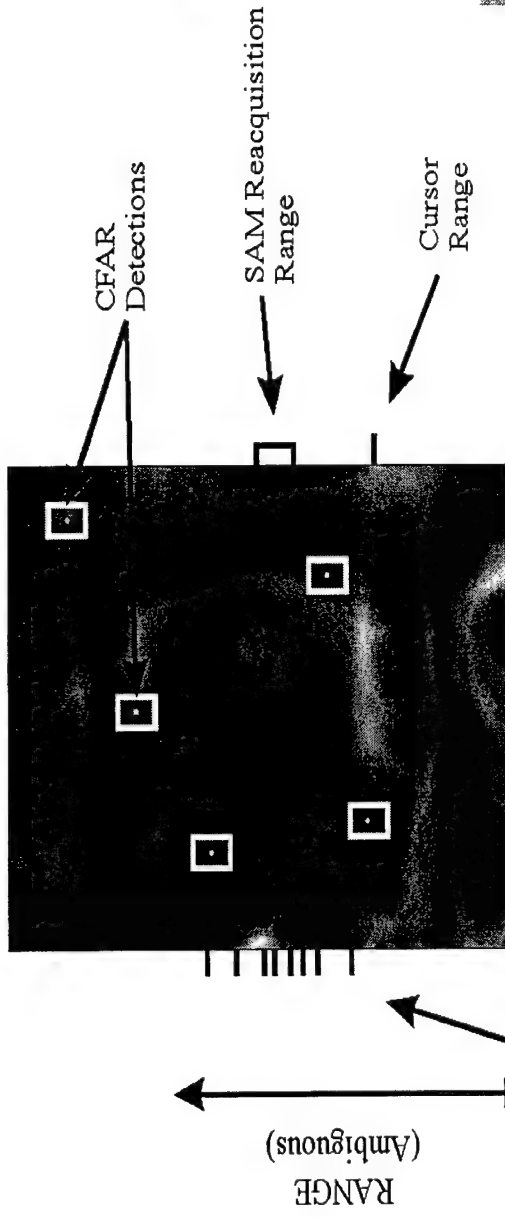


Radar Instrumentation

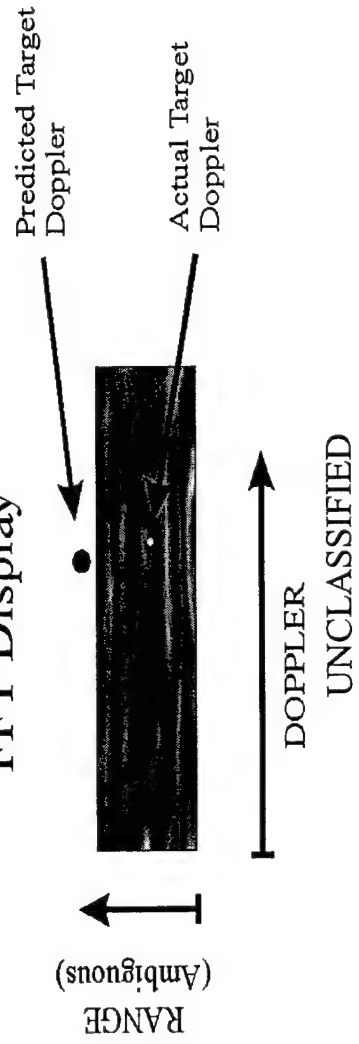


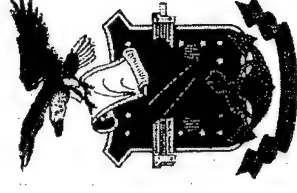
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Air-To-Air Search FFT Display



Air-To-Air Track FFT Display



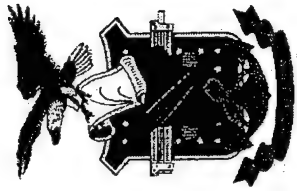


Integration

- Systems are highly integrated
 - Slave to/from each sensor
- Teaches Integrated Systems Concepts to aircrew from non-integrated platforms
- Introduction to Basic HOTAS concepts
- Instrumentation allows for deeper investigation of Radar Processing than in our production F/A-18's

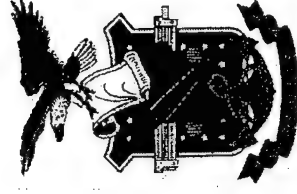
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ASTARS Bridges the Lab to Advanced System



- The ASTARS allows instruction of Flight Test Techniques in a “Classroom” environment in the air.
- Learn and execute the fundamentals of Systems Flight Test in a more benign environment
- Is the build-up to the other advanced systems testing

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Instructional Approach

Multiple Tiers of Exposure

Application of Knowledge

Students apply theory and test techniques to demonstrate mastery.

Applied Theory and Flight Test Techniques

Theory learned in the classroom is combined with FTT in ground-based and airborne simulators and laboratories.

Presentation of Theory

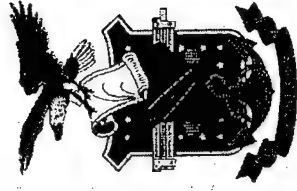
Theory supporting T&E is introduced in the classroom.

Airborne
Tactical
Aircraft
Evaluation

Airborne
Simulator and
Laboratory Exercises
Ground-based

Academic Theory
Classroom

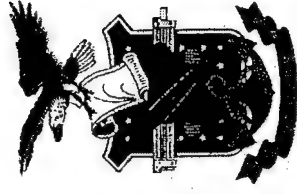
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Recent Syllabus Changes

- Instrumentation/Radar Capabilities of the MLU Upgrade have allowed for deeper theoretical T&E of the APG-66(V)2.
 - Systems students performs an in-depth radar evaluation using on-board instrumentation
 - Fly an F/A-18 OT Prep Exercise
 - Rotary Wing using for Radar Evaluation
 - Test Techniques and a more advanced radar system than in the SH-60B

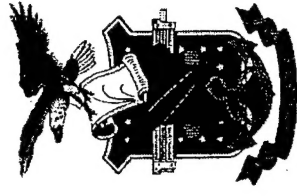
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Recent Syllabus Changes

- Fixed wing use ASTARS to learn Radar Test Techniques
 - Fly a team Radar Test Evolution in the F/A-18

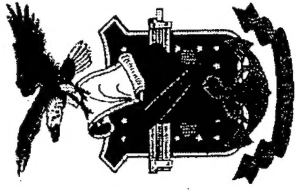
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Future Plans for ASTARS

- Develop a comprehensive Software T&E Exercise
- Add Captive Weapons Seekers
 - Fold into current EO/IR

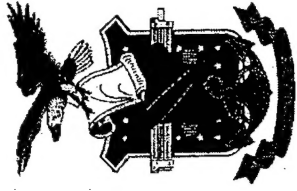
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Summary

- One new start
 - JSF
 - CSA
 - No new Systems - integrate legacy weapons systems
- Systems will continue to be the majority of T&E
 - Upgrades, Add-ons, ATD, Tech Insertion
 - Pressure to cut T&E time/cost

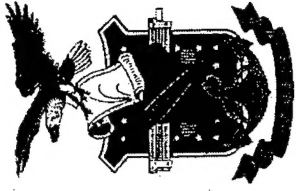
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Summary

- Software complexity exploding
 - Teach a sound standard methodology
- Flying Lab/Classroom is the most effective way develop the end product

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QUESTIONS ???

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